

Project Lead The Way® “Introduction to Engineering Design”
Technology Education – Applied Technology Education
Utah State Office of Education
CIP Code 210120

COURSE DESCRIPTION: This course emphasizes the development of a design. Students use computer software to produce, analyze and evaluate models of projects solutions. They study the design concepts of form and function, then use state-of-the-art technology to translate conceptual design into reproducible products. This course teaches students to:

- Understand and apply the design process to solve various problems in a team setting.
- Apply adaptive design concepts in developing sketches, features, parts and assemblies.
- Interpret their own sketches in using computer software to design models.
- Understand mass property calculations—such as volume, density, mass surface area moment of inertia, product of inertia, radii of gyration, principal, axes and principal moments—and how they are used to evaluate a parametric model.
- Understand cost analysis, quality control, staffing needs, packing and product marketing.
- Explore career opportunities in design engineering and understand what skills and education these jobs require.
- Develop portfolios to display their designs and present them properly to peers, instructors and professionals.

STANDARD & OBJECTIVES

210120.01 OVERVIEW

- 210120.0101 Students will develop an appreciation of how the history of art has influenced innovations in the field of engineering, and explain the impact of artistic expression as it relates to consumer products. (History of Design)
- 210120.0102 Students will research how artistic period and style have influenced product and architectural design. (History of Design)
- 210120.0103 Students will explore the design concept of form and function and explain its use in product design. (History of Design)
- 210120.0104 Students will explore the evolution of technology and be able to identify engineering achievements through history. (History of Design)
- 210120.0105 Students will research the chronological development and accelerating rate of change that innovations in tools and materials have brought about over time as it relates to a given consumer product. (History of Design)
- 210120.0106 Students will review the history of measurement tools and identify two innovations that have led to improved functionality of that tool. (History of Design)
- 210120.0107 Students will explore a given professional organization and summarize in a short PowerPoint presentation the range of services provided by the organization. (Professional Organizations)
- 210120.0108 Students will identify career opportunities in design engineering and explain their job functions. (Career Opportunities)

210120.0109 Students will explore career opportunities in a given engineering field and list the educational requirements for each profession. (Education Requirements)

210120.02 INTRODUCTION TO DESIGN

210120.0201 Students will list the seven steps of the design process and explain the activities that occur during each phase. (Design Process)

210120.0202 Students will assess the value of working as a team and understand the benefits of collaboration. (Design Process)

210120.0203 Students will realize the importance of focusing on detail when executing the design process. (Design Process)

210120.0204 Students will apply the steps of the design process to solve a variety of design problems. (Design Process)

210120.0205 Students will investigate the principles and elements of design and demonstrate their use in the design process incorporating them in design solutions. (Principles and Elements of Design)

210120.0206 Students will identify the use of the principles and elements of design in various products, print media, and art forms. (Principles and Elements of Design)

210120.0207 Students will express their understanding of the principles and elements of design by incorporating them in design solutions. (Principles and Elements of Design)

210120.0208 Students will collect and display examples of the application of the principles and elements of design utilized in products, print media, and art forms. (Principles and Elements of Design)

210120.03 STUDENT PORTFOLIO DEVELOPMENT

210120.0301 Students will identify the proper elements of a fully developed portfolio. (Student Portfolio Development)

210120.0302 Students will identify and discuss the ethical issues surrounding portfolio artifacts. (Student Portfolio Development)

210120.0303 Students will compare and contrast defined elements of a good portfolio specified in the PowerPoint presentation to the sample provided in the PLTW . Design Resource Guide. (Student Portfolio Development)

210120.0304 Students will develop a portfolio to organize and display evidence of their work. (Student Portfolio Development)

210120.04 SKETCHING AND VISUALIZATION

210120.0401 Students will integrate proper sketching techniques and styles in the creation of sketches. (Sketching Techniques)

210120.0402 Students will demonstrate the ability to produce two-dimensional geometric figures. (Sketching Techniques)

210120.0403 Students will select and produce the appropriate pictorial style to best communicate solutions in the design process. (Pictorial Sketching)

- 210120.0404 Students will formulate pictorial sketches to develop ideas, solve problems, and understand relationships during the design process. (Pictorial Sketching)
- 210120.0405 Students will create sketches utilizing both the additive and subtractive methods to assess underlying geometric and perceptual principles. (Pictorial Sketching)
- 210120.0406 The student will select a sketching method that is efficient in its use of color, form, and symbols representing abstract data. (Pictorial Sketching)
- 210120.0407 Students will augment pictorial sketches with shading to improve communication. (Pictorial Sketching)
- 210120.0408 Students will evaluate and select the necessary views to graphically communicate design solutions. (Annotated Sketches)
- 210120.0409 Students will interpret annotated sketches in the design analysis process. (Annotated Sketches)
- 210120.0410 Students will integrate annotated sketches in presentations, portfolio, and documentation process. (Annotated Sketches)
- 210120.0411 Students will develop properly annotated sketches to accurately convey data in a design solution. (Annotated Sketches)

210120.05 GEOMETRIC RELATIONSHIPS

- 210120.0501 Students will define and contrast points, lines and line segments. (Forms and Shapes)
- 210120.0502 Students will identify major geometric shapes (isosceles triangle, right triangle, scalene triangle, rectangles, squares, rhombus, trapezoid, pentagon, hexagon, and octagon). (Forms and Shapes)
- 210120.0503 Using a compass, ruler and triangle students will construct various geometric shapes.
- 210120.0504 Students will define the elements and types of angles. (Forms and Shapes)
- 210120.0505 Using a compass, ruler and triangle students will construct and bisect various types of angles. (Forms and Shapes)
- 210120.0506 Students will define terminology associated with arcs and circles. (Forms and Shapes)
- 210120.0507 Using a compass, ruler and triangle students will construct arcs, circles and ellipses. (Forms and Shapes)
- 210120.0508 Students will distinguish and define geometric constraints. (Geometric Constraints)
- 210120.0509 Students will identify the following geometric constraints in given three-dimensional models: horizontal, vertical, parallel, perpendicular, tangent, concentric, collinear, coincident, and equal. (Geometric Constraints)
- 210120.0510 Students will apply the right hand rule to identify the X, Y, and Z axes of the Cartesian Coordinate System. (Coordinate Systems)
- 210120.0511 Students will apply a combination of absolute, relative, and polar coordinates to construct a three-dimensional model. (Coordinate Systems)
- 210120.0512 Students will define the origin planes in the Cartesian Coordinate System. (Coordinate Systems)
- 210120.0513 Students will identify the origin and planar orientations of each side of a three-dimensional model. (Coordinate Systems)

210120.06 MODELING

- 210120.0601 Students will experience the creative thinking process. (Conceptual Modeling)

- 210120.0602 Students will recognize the difference between vertical and lateral thinking. (Conceptual Modeling)
- 210120.0603 Students will categorize and select a solution to a problem. (Conceptual Modeling)
- 210120.0604 Students will communicate their idea through written and verbal formats. (Conceptual Modeling)
- 210120.0605 Students will identify the different graphical method of data representation. (Graphical Modeling)
- 210120.0606 Students will select the appropriate graphical format to a problem. (Graphical Modeling)
- 210120.0607 Students will analyze and develop graphical representation of given data. (Graphical Modeling)
- 210120.0608 Students will have an understanding of the different physical modeling techniques. (Physical Modeling)
- 210120.0609 Students will present a model with its correct proportions. (Physical Modeling)
- 210120.0610 Students will select the appropriate modeling materials to complete a three-dimensional model. (Physical Modeling)
- 210120.0611 Students will evaluate a problem using mathematical formulae. (Mathematical Modeling)
- 210120.0612 Student will analyze a solution to a problem using the correct format of analysis. (Mathematical Modeling)
- 210120.0613 Students will interpret a sketch and generate a model using a computer and a CAD software package. (Computer Modeling)
- 210120.0614 Students will explain the difference between parametric and adaptive designs and be able to specify their uses. (Computer Modeling)
- 210120.0615 Students will draw a two-dimensional sketch using a CAD package. (Computer Modeling)
- 210120.0616 Students will apply geometrical and dimensional constraints to a sketch. (Computer Modeling)
- 210120.0617 Students will demonstrate the ability to generate a three-dimensional model. (Computer Modeling)
- 210120.0618 Students will understand and demonstrate the use of work features and how they are applied while constructing a solid model. (Computer Modeling)
- 210120.0619 Students will recognize the use and need of work planes, axes, and points in the development of a computer model. (Computer Modeling)
- 210120.0620 Students will demonstrate the ability to modify a sketch or feature of a model. (Computer Modeling)

210120.07 ASSEMBLY MODELING

- 210120.0701 Students will explore and demonstrate assembly-modeling skills to solve a variety of design problems. (Adding Components)
- 210120.0702 Students will understand and apply the base component effectively in the assembly environment. (Adding Components)
- 210120.0703 Students will place and create components in the assembly-modeling environment. (Adding Components)
- 210120.0704 Students will create circular and rectangular patterns of components within an assembly model. (Adding Components)
- 210120.0705 Students will replace components with modified external parts. (Adding Components)
- 210120.0706 Students will perform part manipulation during the creation of an assembly model. (Adding Components)

- 210120.0707 Students will explore and demonstrate assembly-modeling skills to solve a variety of design problems. (Adding Components)
- 210120.0708 Students will explore and demonstrate assembly-modeling skills to solve a variety of design problems. (Assembly Constraints)
- 210120.0709 Students will perform part manipulation during the creation of an assembly model. (Assembly Constraints)
- 210120.0710 Students will apply assembly constraints to successfully construct a multi-part object. (Assembly Constraints)
- 210120.0711 Students will utilize part libraries effectively during the assembly modeling process. (Part Library)
- 210120.0712 Students will explore and demonstrate assembly-modeling skills to solve a variety of design problems. (Part Library)
- 210120.0713 Students will employ sub-assemblies during the production of assemblies. (Sub-Assemblies)
- 210120.0714 Students will explore and demonstrate assembly-modeling skills to solve a variety of design problems. (Sub-Assemblies)
- 210120.0715 Students will understand and apply drive constraints to simulate the motion of parts in assemblies. (Driving Constraints)
- 210120.0716 Students will explore and demonstrate assembly-modeling skills to solve a variety of design problems. (Driving Constraints)
- 210120.0717 Students will explore, understand, and apply adaptive design concepts during the development of sketches, features, parts, and assemblies. (Adaptive Design)
- 210120.0718 Students will explore and demonstrate assembly-modeling skills to solve a variety of design problems. (Adaptive Design)

210120.08 MODELING ANALYSIS AND VERIFICATION

- 210120.0801 Students will demonstrate how to extract mass properties data from their solid models. (Mass Properties)
- 210120.0802 Students will evaluate the accuracy of mass properties calculations. (Mass Properties)
- 210120.0803 Students will describe how analysis data can be used to update parametric models. (Mass Properties)
- 210120.0804 Students will list and explain the various mass property calculations, such as, volume, density, mass, surface area, centroid, moment of inertia, products of inertia, radii of gyration, principal axes, and principal moments, and how they are used to evaluate a parametric model. (Mass Properties)
- 210120.0805 Students will interpret and use correct tolerancing techniques when dimensioning solid models. (Tolerancing)
- 210120.0806 Students will understand and solve tolerance problems, including limits and fits. (Tolerancing)
- 210120.0807 Students will understand the differences between clearance fit, interference fit, and allowance. (Tolerancing)

210120.09 MODEL DOCUMENTATION

- 210120.0901 Students will select the appropriate sheet size and title block for creating a drawing layout. (Working Drawings)

- 210120.0902 Students will translate a three-dimensional drawing or model into corresponding orthographic drawing views. (Working Drawings)
- 210120.0903 Students will describe the purpose, and/or application, of the following drawing views: isometric view, section view, auxiliary view, and detail view. (Working Drawings)
- 210120.0904 Students will generate an isometric view from orthographic drawing views. (Working Drawings)
- 210120.0905 Students will determine the correct application for the various section views required to illustrate an objectTMs internal detail. (Working Drawings)
- 210120.0906 Students will describe the purpose and application of hatch marks and a cutting plane line, as used in a section view. (Working Drawings)
- 210120.0907 Students will create the appropriate section view for a specified application. (Working Drawings)
- 210120.0908 Students will create a detail view that corresponds to the appropriate orthographic drawing view. (Working Drawings)
- 210120.0909 Students will create an auxiliary view to show the detail on an inclined surface of a drawing object. (Working Drawings)
- 210120.0910 Students will list the common dimensioning standards. (Dimensioning)
- 210120.0911 Students will identify and demonstrate the use of common dimensioning systems. (Dimensioning)
- 210120.0912 Students will describe the characteristics and demonstrate the use of unidirectional and aligned dimensioning. (Dimensioning)
- 210120.0913 Students will differentiate the use of and demonstrate an understanding of size and location dimensions by applying these types of dimensions to annotated sketches and drawings. (Dimensioning)
- 210120.0914 Students will demonstrate appropriate dimensioning rules and practices. (Dimensioning)
- 210120.0915 Students will set up and integrate the use of a customized common dimensioning standard. (Dimensioning)
- 210120.0916 Students will identify and demonstrate the use of dimensioning practices on section, auxiliary, and assembly models. (Dimensioning)
- 210120.0917 Students will define and demonstrate an understanding of tolerancing, and solve tolerance problems. (Dimensioning)
- 210120.0918 Students will apply appropriate annotations on sketches and drawings. (Annotation)
- 210120.0919 Students will understand and formulate general and proprietary specifications to further communicate information relating to product design. (Annotation)

210120.10 PRESENTATION

- 210120.0101 Students will demonstrate the following communication techniques: voice variation, eye contact, posture, attire, practice and preparation, and projecting confidence. (Communications Techniques)
- 210120.1002 Students will have an understanding of various forms of visual aids and when to use them in a presentation. (Presentation)
- 210120.1003 Considering the audience and level of formality, students will select the most appropriate type of visual aid for a presentation. (Presentation)
- 210120.1004 Considering the audience and level of formality, students will select the most appropriate type of written documentation for a presentation. (Presentation)
- 210120.1005 Students will identify the elements of the various forms of written documentation. (Presentation)

210120.11 **PRODUCTION**

- 210120.1101 Students will recognize the need to involve all of the manufacturing team members in the decision making process of designing a product. (Manufacturing Design Analysis)
- 210120.1102 Students will be able to categorize manufacturing specifications and constraints needed to produce a product. (Manufacturing Design Analysis)
- 210120.1103 Students will be able to evaluate material characteristics for manufacturing a specific product and identify the correct manufacturing process needed to produce that product. (Manufacturing Design Analysis)
- 210120.1104 Students will evaluate and apply the correct machine process. (Process Planning)
- 210120.1105 Students will recognize the need to limit the number of processes used to manufacture a product. (Process Planning)
- 210120.1106 Students will develop an understanding of process routing. (Process Planning)
- 210120.1107 Students will distinguish the differences between CNC, FMS, and CIM. (Design for Automated Manufacturing)
- 210120.1108 Students will explain the need for a company to minimize material handling by procurement of materials in a timely fashion. Students should explain the JIT process. (Materials, Procurement, Handling & Cost Analysis)
- 210120.1109 Students will identify the need to perform a cost analysis of a product. (Materials, Procurement, Handling & Cost Analysis)
- 210120.1110 Students will interpret data, which has been statically analyzed, to ensure product quality. (Quality Control)
- 210120.1111 Students will identify the need to evaluate the areas of manpower and facility requirements. (Manpower and Facility Requirements)
- 210120.1112 Students will recognize the need to protect a product for shipping. (Packaging)
- 210120.1113 Students will analyze aesthetic requirements to enhance packaging for the consumer. (Packaging)

210120.12 **MARKETING**

- 210120.1201 Students will define, explain, and demonstrate an understanding of common vocabulary words used in association with product cost analysis. (Product Analysis)
- 210120.1202 Students will formulate a product cost analysis for a given product. (Product Analysis)
- 210120.1203 Students will demonstrate an understanding of packaging design requirements. (Packaging Requirements)
- 210120.1204 Students will design a package for a given product. (Packaging Requirements)